**How this investigation fits within the “Concept and Lesson Map”:**

**Overview for Investigation 2**

Students will discover different ways to produce rotational motion and explore variables that influence the spinning of tops, zoomers, and twirlers.

This investigation should be completed after the supplemental investigations into force and motion

**Overarching question(s) for this whole investigation:**

* In what ways can a spinning object be kept in motion and how can that motion be changed?

**How People Learn Key Finding #1: Preconceptions**

**Eliciting Students Ideas:**

* Prior to starting Part 1, use the Formative Assessment Probe: Spinners, to begin discussions about rotational motion and size/mass of the object spinning. The focus shouldn’t be on a “right” or “wrong” answer, rather on uncovering preconceptions and beginning to draw out vocabulary students are using to describe what they think and what evidence they have to support it. This is first and foremost a conversation starter. Students should record their thoughts first so that they can reflect on them after the investigation, but after recording their ideas they should engage in a whole group discussion about their predictions.

**Common Student Preconceptions:**

* Students generally regard the state of rest (balance) as fundamentally different from the state of motion. (Driver)
* Young children will state that an object will stop moving or fall over because it wants to. (Driver)
* For something to move it must have a constant force or push. (Driver)
* If a body is not moving there is no force acting on it. (Driver)

**How People Learn Key Finding #2: Facts/Concepts/Knowledge**

**WA State Content Standards “Science Domains” (EALR 4):**

* 2-3 PS1A Motion can be described as a change in position over a period of time.
* 2-3 PS1B There is always a force involved when something starts moving or changes its speed or direction of motion.

**WA State Content Standards “Science Domains” (EALRs 1-3):**

* + 2-3 SYSA A *system* is a group of interacting parts that *form* a whole.
  + 2-3 INQA Scientific investigations are designed to gain knowledge about the natural world.
  + 2-3 INQC Inferences are based on observations.
  + 2-3 INQE Models are useful for understanding systems that are too big, too small, or too dangerous to study directly.
  + 2-3 INQF Scientists develop explanations, using observations (evidence) and what they already know about the world. Explanations should be based on evidence from investigations.

**Benchmarks for Science Literacy:**

* 1a When a science investigation is done the way it was done before, we expect to get a very similar result.
* 1a Science investigations generally work the same way in different places
* 1b People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.
* 1b Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.
* 1b When people give different descriptions of the same thing, it is usually a good idea to make some fresh observations instead of just arguing about who is right.
* 1c Everybody can do science and invent things and ideas
* **1c In doing science, it is often helpful to work with a team and to share findings with others. All team members should reach their own individual conclusions, however, about what the findings mean.**
* **4f Things move in many different ways, such as straight, zigzag, round and round, back and forth, and fast and slow.**
* **4f The way to change how something is moving is to give it a push or a pull.**
* **4g Things near the earth fall to the ground unless something holds them up.**
* 6d People can learn from each other by telling and listening, showing and watching, and imitating what others do.
* 9d Some things are more likely to happen than others. Some events can be predicted well and some cannot. Sometimes people aren’t sure what will happen because they don’t know everything that might be having an effect.
* 9e People are more likely to believe your ideas if you can give good reasons for them.
* 12a Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out.
* 12d Draw pictures that correctly portray at least some features of the thing being described.
* 12e Ask “How do you know?” in appropriate situations and attempt reasonable answers when others ask them the same question.

**Key understandings for the teacher:**

* Rotational motion can be difficult for students to understand because the “motion” isn’t linear—the spinners don’t necessarily move across the table. Focusing on the *changes* in movement with big and small parts or strength of force applied are entirely within their grasp.

**How People Learn Key Finding #3: Metacognition**

**Metacognition: How did my thinking change? What caused the change? How did I come to believe this?**

* After finishing Investigation2, students should return to the Formative Assessment Probe question about the tops. After recording their new ideas, students should return to their initial predictions and try to identify how their thinking changed and what experiences changed their thinking.

**Suggested Assessments for Student Understanding:**

* After Part 1: Tops, use the modified Washington Edition of Assessment to assess understanding of rotational motion and changes in direction of force. This can be collected or pasted into a Science Notebook.

**Additional Information**

**Materials and Student Management**

* In part 1: Tops, the focus is a little scattered in terms of looking for tops that spin faster or slower and with more or less stability. Consider focusing the lesson on making tops that spin faster or slower; differences in stability can be noted and discussed, but not dwelt upon.
* In part 2: Zoomers, the focus should be on where does the force come from that starts the zoomer going?
* Part 3: Twirlers can be very challenging for the students who still have difficulty cutting “only on the solid lines” and folding on the dotted ones. Some options for differentiation may include having them pre-cut so only folding is necessary; or using graph paper and letting them create the design themselves (in the style of the old T-copter experiment.) By creating their own, students can explore whether longer “wings” make a twirler go faster or slower.
* Many children’s toys are “spinners,” consider hosting “sharing” times for students to bring in examples from home of toys that spin. Discussion could center around which parts of the toy spin and how the toy could be changed to make it spin faster or slower.
* A good PE connection is teaching a “spin jammer” unit. (Spinning Frisbees on one finger).

**Timing Considerations**

* The students may want more opportunities to make tops or other spinners; leaving the materials out at a “station” could encourage further explorations.
* “Zoomers” may be frustrating at first as students figure out how to “wind it up.”